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(54) [Title of Invention]
FLUORESCENCE OBSERVATION ENDOSCOPE APPARATUS

(57) [Abstract]
[Purpose]
To detect fluorescence of two specific wavelengths without performing mechanical switching by a rotatable filter, etc.

[Summary of the Invention]
An endoscope 4 of a fluorescence observation endoscope apparatus 1 comprises:
a light guide 10 which introduces a laser beam emitted from a laser 9 into internal body cavities;
a concave lens 11 which diffuses and illuminates the laser beam;
an objective lens which projects fluorescence images of a lesion 3 onto a color image detecting element 5; and
an optical filter 13 which transmits specific wavelengths of the aforementioned fluorescence image.
The optical filter 13 has the transmission characteristic which transmits a green color of 500 – 540nm and a red color of 640 – 700nm.

[Claims]
[Claim 1]
A fluorescence observation endoscope apparatus that irradiates an excitation light into an organ in the body cavity by endoscope and observes fluorescence light from the tissue in two-dimensional images, which is characterized by the fact that an image detecting element having sensitivity in several different wavelength bands and converts the aforementioned two-dimensional images into electrical signals, and an optical filter for transmitting wavelengths in at least two regions from the aforementioned wavelength bands is arranged on the light receiving side of the image detecting element.

[Detailed Description of the Invention]
[0001]
[Technical Field of the Invention]
This invention relates to a fluorescence observation endoscope apparatus which irradiates light using an endoscope and performs observation diagnosis of lesions such as cancer according to the observation of fluorescence emitted from tissue, especially to detect and image several specific wavelengths of fluorescence.

[0002]
[Prior Art]
In recent years, techniques such as auto-fluorescence, which is generated directly from living tissue by irradiating the excitation light to an observation area of living tissue, and drug-induced fluorescence, which is generated by injecting a fluorescent drug into the organism beforehand, produce two-dimensional images which are used to diagnose the

degeneration of tissues of the organism or a state of the disease (for example, the type of the disease or the extent of infiltration), such as a cancer. These techniques are disclosed in the United States Patent Numbers 4556057 and 5042494.

[0003]
If excitation light irradiates living tissue, the wavelength of the fluorescence generated will be longer than that of the excitation light.
Fluorescence substances in the organism are, for example, collagen, NADH (nicotinamide adenine dinucleotide), FMN (flavin mononucleotide), pyridine nucleotide, etc.
Recently, the interrelation between these substances in the organism emitting fluorescence light and diseases is becoming clear, and the diagnosis of cancer, etc. is possible from this fluorescence.

[0004]
Alternatively, a fluorescence substance such as HpD (hematoporphyrin), Photofrin, ALA(δ-amino levulinic acid), etc., may be injected into an organism. These substances have a tendency to accumulate in cancerous tissue, and a diseased area can be diagnosed by observing the fluorescence after injecting any of these substances into an organism.

[0005]
[Problem to be Solved by the Invention]
Techniques for diagnosing lesions by fluorescence using an endoscope is filed in the Unexamined Japanese Patent Number H5-304427 by the same applicants. This device detects autofluorescence emitted from the tissue in two bands of red and green regions and this image is displayed by processing images. A rotatable filter is used for switching the aforementioned regions of light.

[0006]
However, there is a problem with this type of apparatus being large and expensive because a rotatable filter, etc are switched mechanically in order to detect fluorescence in two wavelength regions.

[0007]
This invention is formed in consideration of the above-mentioned matters. The purpose is to provide a fluorescence observation endoscope apparatus capable of detecting two specific wavelengths in fluorescence without mechanical switching of a rotatable filter, etc.

[0008]
[Means and Operation to Solve the Problem]
In a fluorescence observation endoscope apparatus of this invention in which the excitation light irradiates an organ in a body cavity and fluorescence from the tissue is observed as two-dimensional images, an optical filter to transmit wavelengths in at least two regions from the aforementioned wavelength bands is arranged on the light-receiving side of an image-detecting element, which has sensitivity in several different wavelength bands and converts the aforementioned two-dimensional images into electrical signals. Thus, it is capable of detecting fluorescence in two specific wavelengths by transmitting wavelengths in at least two regions by the aforementioned optical filter without performing mechanical switching of a rotatable filter, etc.

[0009]
[Embodiment]
Hereafter, embodiments of this invention will be explained referring to drawings.

[0010]
Fig 1 through Fig. 4 relate to a first embodiment of this invention. Fig. 1 is a block diagram showing the overall structure of a fluorescence observation endoscope apparatus which diagnoses a lesion according to fluorescence. Fig. 2 is a characteristic diagram showing the transmission characteristic of an interference filter of the optical filter in Fig. 1. Fig. 3 is a characteristic diagram showing the transmission characteristic of a color filter of the optical filter in Fig. 1. Fig. 4 is a characteristic diagram showing the transmission characteristic of the optical filter and the spectral characteristic of a color image detecting element.

[0011]
(Constitution)
As shown in Fig. 1, a fluorescence observation endoscope apparatus 1 of this embodiment comprises:
a light source 2 for generating light (excitation light) in the blue or ultraviolet regions;
an endoscope 4 to guide the excitation light into a body cavity and observe fluorescence emitted from a lesion 3;
a camera control unit 6 which converts fluorescence images of the lesion 3 into video signals by operating the color image detecting element 5 which is built into the endoscope 4;
an image processor 7 to process the video signals so as to identify the lesion 3 and a normal area easily; and
a monitor 8 for displaying the image output of the image processor 7.

[0012]
The aforementioned light source 2 is provided with a laser such as an excimer, He-Cd, argon lasers, etc to emit light in the blue or ultraviolet region.
The aforementioned endoscope 4 comprises:
a light guide 10 for guiding a laser light generated by the aforementioned laser 9 into an internal body cavity;
a concave lens 11 which diffuses and illuminates the laser light;
an objective lens 12 to project fluorescence mages of a lesion 3 onto a color image detecting element 5; and
an optical filter 13 to transmit specific wavelengths of fluorescence images from the objective lens 12.

[0013]
The optical filter 13 has the transmission characteristic of the green color of 500 - 540nm and red color of 640 – 700nm.

[0014]
The optical filter 13 consists of an interference filter with the transmission characteristic shown in Fig. 2 and a color filter with the transmission characteristic shown in Fig. 3 so that the optical filter 13 has the overall transmission characteristics as shown in a solid line in Fig. 4.

[0015]
In addition, the aforementioned light source 2 is provided with: a xenon lamp which generates white light; a laser 9; and a switching device which supplies the light of the xenon lamp to the light guide 10 by switching. (not illustrated)
The endoscope 4 has a built-in image-detecting element (not illustrated) for capturing images by white light.

[0016]
(Operation)
A laser light emitted from the laser 9 is incident to the light guide 10 which is built into the endoscope 4 and guided to the internal body cavity. The laser light diffused by the concave lens 11 irradiates the internal body cavity. By the laser light, autofluorescence is emitted from the lesion 3 and the periphery of normal area, and it is projected onto the color image-detecting element 5 via the objective lens 12. At this time, the optical filter 13 is arranged between the objective lens 12 and the color image-detecting element 5 as a solid line in Fig. 4 so as to transmit a green light in 500 - 540nm and a red light in 640 - 700nm.

[0017]
On the other hand, the color image-detecting element has the spectral sensitivity in each red, green, and blue region as a broken line in Fig. 4. Fluorescence in the overlapping areas of the aforementioned optical filter 13 and the color image-detecting element 5 enters the color image-detecting element 5. That is, 500-540nm enters the green area and 640-700nm enters the red area. This color image-detecting element 5 in combination with camera control unit 6 converts light from each spectral region into a different RBG color video signal.

[0018]
R signal is fluorescence in 640-700nm and G signal is fluorescence in 500-540nm. The weighing or linearity compensation of each RGB signal is performed by the image processor 7. This weighing is set to make discrimination between a normal areas and lesions easier and to decrease misdiagnosis diagnosis.

[0019]
In addition, the optical filler 13 may be comprised to transmit the light containing near 480 - 560nm and 620 - 700nm.

[0020]
(Effect)
As mentioned above, by corresponding two wavelength areas of the optical filter 13 to the R, G, or B spectral characteristic of the color image-detecting element, the fluorescence in two wavelength regions can be extracted as R, G, and B video signals. Then, the weighing and sensitivity compensation can be performed independently on each fluorescence wavelength band and a lesion and a normal area can be displayed to be distinguished more clearly. Moreover, it is possible to reduce the size of apparatus since only one image-detecting element is used for capturing fluorescence images.

[0021]
Next, a second embodiment will be explained. Fig. 5 and Fig. 6 relate to the second embodiment of this invention. Fig. 5 is a block diagram showing the structure of the distal end of an endoscope of a fluorescence observation endoscope apparatus. Fig. 6 is a block diagram showing the modified structure of the distal end of the endoscope in Fig. 5. Since the second embodiment is very similar to the first embodiment, only different components will be explained. The same symbols are used for the same parts and the explanations of those will be omitted.

[0022]

The technique to diagnose lesions from fluorescence using endoscope is explained in the Japanese Patent Number S63-234939. A filter for blocking excitation light which extracts only fluorescence is provided between the image detecting element and the objective lens in the distal end of an endoscope and this filter is operated by a wire so as to be inserted into an optical path.

[0023]
However, as for the method to operate an excitation light blocking filter by wire, the length of wire becomes longer in correspond to the length of endoscope and the resistance of moving wire would increase by the bend of endoscope, etc. Thus, there is a problem with bad compliance or response.

[0024]
Thus, in the second embodiment, a fluorescence observation endoscope apparatus, which enables to switch with a quick response by inserting/removing a filter for fluorescence observation between an image-detecting element and an objective lens by a piezoelectric actuator, will be explained.

[0025]
In the first embodiment, the apparatus is comprised by an image-detecting element (not illustrated) for capturing white images in addition to the color image-detecting element 5 for detecting fluorescence images. In this embodiment, both fluorescence images and white light images are switched using one color image-detecting element 5 by inserting/removing the optical filter 13 of the first embodiment.

[0026]
(Constitution)
As shown in Fig. 5, an optical filter inserting/removing device 14 is provided in the distal end on the observation side of an endoscope 4, and which consists of a piezoelectric actuator 15, a base 16 to maintain the piezoelectric actuator 15 by frictional force, and an optical filter 13 containing a rotatable shaft 18, and an actuator control circuit (not illustrated) which controls the operation of the piezoelectric actuator 15. Other components are the same as that of the first embodiment.

[0027]
(Operation)
At the time of fluorescence observation, the optical filter 13 is inserted into an optical path between the color image detecting element 5 and the objective lens 12 as a solid line in Fig. 5. The optical filter 13 and the color image detecting element 5 have the same characteristics as shown in Fig. 4 of the first embodiment and the fluorescence in 500-540nm and 640-700nm are outputted as R signal and G signal of video signals.

[0028]
On the other hand, at the time of white-light observation, the piezoelectric actuator 15 is moved to the position shown as a dotted line in Fig. 5 by the actuator control circuit. Thus, the optical filter 13 is removed from the optical path by the rotation centering the rotation shaft 18. At this time, the light from the light source 2 is switched from the excitation light to the white light in synchronization with this operation, and this light is captured as a normal color image by the color image detecting element 5.

[0029]
The piezoelectric actuator 15 is consisting of piezoelectric elements. The piezoelectric actuator 15 stretches and shrinks very quickly by applying positive or negative voltage to one end of this piezoelectric element for a short time. Thus, with the pressure, the piezoelectric actuator 15 moves forward and backward. Then, the piezoelectric elements are maintained at the position by reducing the voltage not to exceed the aforementioned frictional force of the piezoelectric elements and the base. By repeating this operation, it can be moved forward and backward like an inchworm.

[0030]
(Effect)
In addition to the effect of the first embodiment, in this embodiment, a fluorescence image and white light image can be switched reliably and an apparatus can be made smaller using the piezoelectric actuator 15.

[0031]
Fig. 6 is a modification of Fig. 5 and an example using a monochromatic image-detecting element instead of the color image-detecting element 5.

[0032]
(Constitution)
An optical filter inserting/removing apparatus 20 of Fig. 6 comprises:
a first piezoelectric actuator 21;
a first base 22 to maintain the piezoelectric actuator 21 by frictional force;
a rotatable first optical filter 23;
a second piezoelectric actuator 24;
a second base 25 to maintain the piezoelectric actuator 24 by frictional force;

a rotatable second optical filter 26; and
a monochromatic image-detecting element 19 having sensitivity in a visible region. Other components are similar to that of the first embodiment and explanations of those will be omitted.

[0033]
(Operation)
Optical filters 23 and 26 are rotatably moved along the first and second groove 27 and 28 by piezoelectric actuators 21 and 24 respectively. For example, the optical filter 23 transmits the light of 500-540nm; the optical filter 26 transmits the light of 640-700nm. On the other hand, the monochromatic image-detecting element 19 has sensitivity for all visible regions. That is, by sequentially inserting/removing the optical filters 23 and 26 by the piezoelectric actuators 21 and 24, images can be captured as a video signal in each wavelength. Moreover, for white-light observation, white-light images can be acquired by removing the optical filters 23 and 26 from the optical path and sequentially irradiating R, G, and B lights. Other operations are the same as that of the first embodiment.

[0034]
(Effect)
Thus, in addition to the effect of the first embodiment, fluorescence images and white-light images with high resolution can be acquired using the monochrome image-detecting element.

[0035]
Next, a third embodiment will be explained. Fig. 7 is a block diagram showing the structure of the distal end of an endoscope of a fluorescence observation endoscope apparatus for the third embodiment of this invention. The third embodiment is almost the same as the first embodiment. Thus, only different components will be explained and the same symbols are utilized for the same parts and explanations of those will be omitted.

[0036]
As the first and second embodiments, when the ultraviolet to blue excitation light is passed through optical fibers comprising a light guide 10, fiber itself emits fluorescence and light other than excitation light irradiates an organism. Thus, autofluroescence from the organism is detected with this fluorescence so that this may cause the reduction in contrast of fluorescence image.

[0037]
Therefore, in addition to the first embodiment, the purpose of the third embodiment is to provide fluorescence images having high contrast by arranging a filter which transmits the excitation light to the emission end of the light guide and absorbs or reflects the light except excitation light, especially the light in longer wavelengths.

[0038]
Fig. 7 illustrates the structure to block fluorescence emitted by a light guide when the excitation light from the light source 2 is entered.

[0039]
As for the third embodiment, a fluorescence blocking device 29 is provided in the distal tip of the endoscope 4 to block fluorescence generated from the light guide 10 as shown in Fig. 7.
The fluorescence blocking device 29 for the light guide 10 is provided with:
an excitation light transmission filter 30 for transmitting the excitation of the light source 2;
a piezoelectric actuator 31 for rotationally moving the excitation light transmission filter 20 from the optical path; and
a base 32 to maintain the piezoelectric actuator 31 by frictional force.
Other components are the same as that of the first embodiment.

[0040]
(Operation)
First, at the time of fluorescence observation, when the excitation light, especially blue to ultraviolet light with high energy, is incident into the light guide 10, fluorescence due to material of the light guide 10 is generated in visible regions. Thus, only excitation light is transmitted by the excitation light transmission filter 30 and fluorescence [from the light guide] is removed. On the other hand, at the time of white-light observation, by removing the excitation light transmission filter 30 from the optical path, white light irradiates the internal body cavity.
[0041]
The operation of the piezoelectric actuator 31 which inserts/removes the transmission filter for excitation light 30 in/from the optical path has the same operation as the piezoelectric actuator 15 of the second embodiment in Fig. 5 so that explanations will be omitted.

[0042]
(Effect)
According to this embodiment, since the reflected light of fluorescence of the light guide can be removed, autofluorescence from the tissue can be

detected with a good S/N. The ability to distinguish diseased areas from normal areas can further be improved.

[0043]
Next, a fourth embodiment will be explained. Fig. 8 and Fig. 9 relate to the fourth embodiment of this invention. Fig. 8 is a block diagram showing the structure of a fluorescence observation endoscope apparatus. Fig. 9 is a sectional view showing the structure of an optical probe in Fig. 8. The fourth embodiment is almost the same as the first embodiment so that only different components will be explained and the same symbols are utilized for the same parts and the explanations of those will be omitted.

[0044]
The fourth embodiment is an example which uses an optical probe inserted into the channel of the endoscope 4 instead of the light guide 10 of the endoscope 4 to supply the excitation light.

[0045]
As for this embodiment, the excitation light from the laser 9 irradiates an internal body cavity via the probe 34 inserted in the channel 33 of the endoscope 4. A white-light source such as Xe lamp 35 is provided in the light source 2.

[0046]
As shown in Fig. 9, the optical probe 34 comprises:
an optical fiber 36 for transmitting excitation light;
a transmission filter for excitation light 37 for transmitting only excitation wavelength;
a concave lens 38 for diffusing excitation light into internal body cavities;
the aforementioned optical fiber 36;
the excitation light transmission filter 37;
a pipe 39 to fix the concave lens 38; and
a tube 40 to protect the optical fiber 36.

[0047]
Other components and operations are the same as that of the first embodiment.

[0048]
According to this embodiment, since the optical probe 34 that is exclusive for excitation light is provided, the same effect as the third embodiment can be obtained without requiring such as the actuator 31 in the third embodiment.

[0049]
Hereafter, the control of acquiring white-light images by the white light and excitation-light images by the excitation light for the above-mentioned embodiments will be explained.

[0050]
Fig. 10 is a block diagram showing the structure of a fluorescence observation endoscope apparatus which performs the acquisition control of white light images and excitation light images.

[0051]
Fig. 10 is a fluorescence observation endoscope apparatus 41 for fluorescence observation.
This fluorescence observation endoscope apparatus 41 is provided with:
a light source 42 which contains a Xe lamp for white light, a laser for excitation light, and a switching device to select the white light or the excitation light;
an endoscope 43 for transmitting the light from the light source 42 into internal body cavities and for capturing white-light images and fluorescence images of the organism's tissue;
a camera 45 which contains a white-light camera to capture white-light images and a high sensitivity fluorescence camera for capturing fluorescence images which are detachably attached to an eyepiece part 44 of the endoscope 43 (not illustrated), and a switching device to switch a camera in synchronization with the light from the aforementioned light source 42;
a camera control unit 46 for converting into video signals by operating the aforementioned camera 45;
an image processor 47 to make lesions and normal areas easily recognizable by processing video signals;
a monitor 48 to display outputs of the image processor 47 as images;
a VTR 49 for recording white-light images and fluorescence images;
a video printer 50 to print white-light images and fluorescence images; and
a control unit 51 for controlling the light source 42, the camera control unit 46, the VTR 49, and the video printer 50.

[0052]
The endoscope 43 consists of an elongate insertion part 52 and an operating part 53 provided at the proximal end of the insertion part 52. The control unit 51 can be remote-operated by operating push button controlled-type switches A 54 and B 55 and a mode transfer switch 56. The buttons 57 in the illustration are used to operate air pumping/water pumping and the suction function of endoscope. Also, a universal cable 58 is extended from the operating part 53 of the endoscope 43 and that distal end is detachably connected to the light source 42. The white light and excitation light from the light

source 42 is transmitted to the distal end of the endoscope 43 by the light guide, which is inserted through the universal cable 58 and the insertion part 52 (not illustrated), and irradiates toward a lesion from the distal end of the endoscope. White-light images and fluorescence images are transmitted to the eyepiece part 44 by the image guide which is inserted through the insertion part 52 and the operating part 53 (not illustrated) and they are captured by the camera 45.

[0053]
With this type of structure, it is possible to switch between a fluorescence image and a white light image; a moving image and a still image, by operating the switches A 54, B 55 and the mode transfer switch 56.

[0054]
That is, when a mode transfer switch 56 is pushed first, as shown in Table 1, the mode is sequentially switched to 1, 2, 3, 1... For example, push the switch 56 if the condition is mode 1, a white light image is switched to a fluorescence image. At this time, the control unit switches from the white light to the excitation light in the light source 42 and the white-light camera to the fluorescence sensitivity camera in the camera 45. At this time, if the switch B 55 is pushed, a still image is displayed and a live image is displayed by pushed the button again.

[0055]
[Table 1]

Mode	Switch A	Switch B
1	White-light Image/ Fluorescence image	Moving Image/ Still Image
2	Sensitivity Increase	Sensitivity Decrease
3	Recording ON/OFF	Printout

At the mode 2, it is possible to adjust the sensitivity of fluorescence high sensitivity camera. If the switch A 54 is pushed, the sensitivity increases. If the switch B 55 is pushed, the sensitivity decreases. At the mode 3, the ON/OFF of the recording of VTR 49 and the printout of the video printer 50 can be performed by operating the switches A 54 and B 55. The array of the functions of each mode and switch and other functions are not limited to this.

[0056][Additional Remarks]
(Additional Remark 1)
In a fluorescence observation endoscope apparatus in which the excitation light irradiates an organ in a body cavity and fluorescence from the tissue is observed as two-dimensional images, an optical filter to transmit wavelengths in at least two regions from the aforementioned wavelength bands is arranged on the light-receiving side of an image-detecting element, which has sensitivity in several different wavelength bands and converts the aforementioned two-dimensional images into electrical signals.

[0057]
(Additional Remark 2)
The fluorescence observation endoscope apparatus mentioned in Additional Remark 1 in which the aforementioned image-detecting element is provided at the distal end of an endoscope and the aforementioned optical filter is arranged on the optical path between an objective lens and the aforementioned image-detecting element.

[0058]
(Additional Remark 3)
The fluorescence observation endoscope apparatus mentioned in Additional Remark 1 in which the aforementioned image-detecting element has sensitivity in each red, green, and blue region.

[0059]
(Additional Remark 4)
The fluorescence observation endoscope apparatus mentioned in Additional Remark 3 in which the aforementioned filter transmits a part of wavelength band in the red and green areas of the aforementioned image-detecting element and reflects or absorbs other than that (wavelength band).

[0060]
(Additional Remark 5)
The fluorescence observation endoscope apparatus mentioned in Additional Remark 4 in which the aforementioned filter transmits the light containing the wavelengths near 480 - 560nm and 620 - 700nm.

[0061]
(Additional Remark 6)
A fluorescence observation endoscope apparatus in which the excitation light irradiates organs in body cavities and fluorescence from the tissue is observed as two-dimensional images,
which is provided with an inserting/removing means, which inserts or removes an optical filter transmitting specific wavelength regions from the optical path of an image-detecting element provided at the distal end of the aforementioned endoscope for converting two-dimensional images into electrical signals and the objective lens of the endoscope by a movable actuator consisting of piezoelectric elements.

[0062]
(Additional Remark 7)
The fluorescence observation endoscope apparatus mentioned in Additional Remark 6 in which the aforementioned image-detecting element has sensitivity in each red, green, and blue region.

[0063]
(Additional Remark 8)
The fluorescence observation endoscope apparatus mentioned in Additional Remark 7 in which the aforementioned optical filter transmits a part of wavelength band in red and green areas of the aforementioned image-detecting element and reflects or absorbs other than that (wavelength band).

[0064]
(Additional Remark 9)
The fluorescence observation endoscope apparatus mentioned in Additional Remark 8 in which the aforementioned optical filter transmits light containing the wavelengths near 480 – 560nm and 620 – 700nm.

[0065]
(Additional Remark 10)
The fluorescence observation endoscope apparatus mentioned in Additional Remark 6 in which the aforementioned image-detecting element has sensitivity in visible regions.

[0066]
(Additional Remark 11)
The fluorescence observation endoscope apparatus mentioned in Additional Remark 10 in which there are at least two optical filters and actuators and each optical filter transmits a different wavelength region.

[0067]
(Additional Remark 12)
The fluorescence observation endoscope apparatus mentioned in Additional Remark 11 in which the aforementioned optical filter transmits light containing wavelengths near 480-560nm and 620-700nm.

[0068]
(Additional Remark 13)
In a fluorescence observation endoscope apparatus in which the excitation light irradiates organs in body cavities using endoscope and fluorescence from the tissue is observed as two-dimensional images, an excitation light transmission filter is arranged to transmit only excitation light to the light emission end of a transmission means for the aforementioned excitation light and reflects or absorbs the light having longer wavelengths.

[0069]
(Additional Remark 14)
The fluorescence observation endoscope apparatus mentioned in Additional Remark 13 in which the aforementioned excitation light transmission means is a light guide provided in the endoscope.

[0070]
(Additional Remark 15)
The fluorescence observation endoscope apparatus mentioned in Additional Remark 13 in which the aforementioned excitation light transmission means is an optical probe having a diameter in which the channel of the endoscope can be inserted.

[0071]
(Additional Remark 16)
The fluorescence observation endoscope apparatus mentioned in Additional Remark 13 in which the excitation light transmission filter transmits the light containing a wavelength shorter than 450nm.

[0072]
(Additional Remark 17)
The fluorescence observation endoscope apparatus mentioned in Additional Remark 14 in which aforementioned excitation light transmission filter can be inserted into the optical path.

[0073]
(Additional Remark 18)
The fluorescence observation endoscope apparatus mentioned in Additional Remark 17 in which the aforementioned inserting/removing means is a movable actuator consisting of piezoelectric elements.

[0074]
[Effect of the Invention]
As described above, according to a fluorescence observation endoscope apparatus of this invention, an optical filter to transmit wavelengths in at least two regions from the aforementioned wavelength bands is arranged on the light-receiving side of an image-detecting element, which has sensitivity in several different wavelength bands and converts the aforementioned two-dimensional images into electrical signals. Thus, at least two wavelengths in the wavelength bands can be transmitted by the optical filter, and fluorescence having two specific wavelengths can be detected without performing mechanical switching by a rotatable filter, etc.

[Brief Explanation of the Drawings]

[Fig. 1]
Fig. 1 is a block diagram showing the overall structure of a fluorescence observation endoscope apparatus which diagnoses a lesion according to fluorescence for the first embodiment of this invention.

[Fig. 2]
Fig. 2 is a characteristic diagram showing the transmission characteristic of an interference filter of the optical filter in Fig. 1.

[Fig. 3]
Fig. 3 is a characteristic diagram showing the transmission characteristic of a color filter of the optical filter in Fig. 1.

[Fig. 4]
Fig. 4 is a characteristic diagram showing the transmission characteristic of the optical filter of Fig. 1 and the spectral characteristic of a color image-detecting element.

[Fig. 5]
Fig. 5 is a block diagram showing the structure of the distal end of an endoscope of a fluorescence observation endoscope apparatus for the second embodiment of this invention.

[Fig. 6]
Fig. 6 is a block diagram showing the modified structure of the distal end of the endoscope in Fig. 5.

[Fig. 7]
Fig. 7 is a block diagram showing the structure of the distal end of an endoscope of a fluorescence observation endoscope apparatus for the third embodiment of this invention.

[Fig. 8]
Fig. 8 is a block diagram showing the structure of a fluorescence observation endoscope apparatus for the fourth embodiment of this invention.

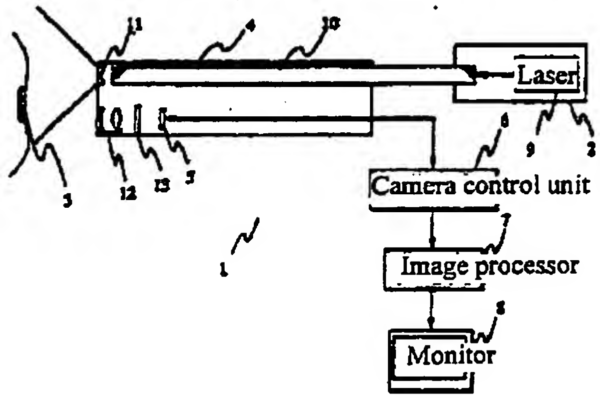
[Fig. 9]
Fig. 9 is a sectional view showing the structure of an optical probe in Fig. 8.

[Fig. 10]
Fig. 10 is a block diagram showing the structure of a fluorescence observation endoscope apparatus which performs the acquisition control of white light images and excitation light images.

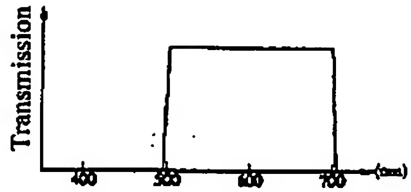
[Explanations of Symbols]

1...fluorescence observation endoscope apparatus
2...light source
3...lesion
4...endoscope
5...color image-detecting element
6...camera control unit
7...image processor
8...monitor
9...laser
10...light guide
11...concave lens
12...objective lens
13...optical filter

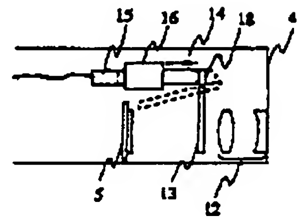
[Fig. 1]



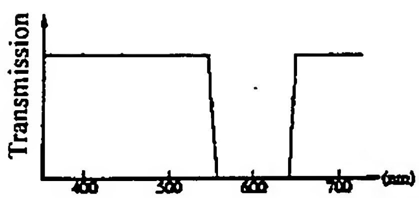
[Fig. 2]



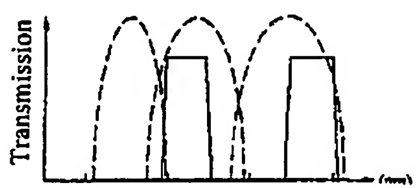
[Fig. 5]



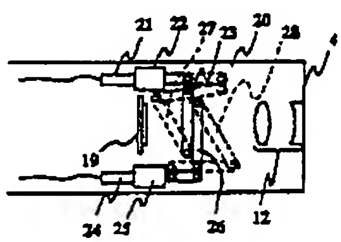
[Fig. 3]



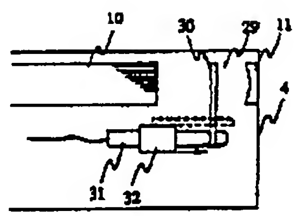
[Fig. 4]



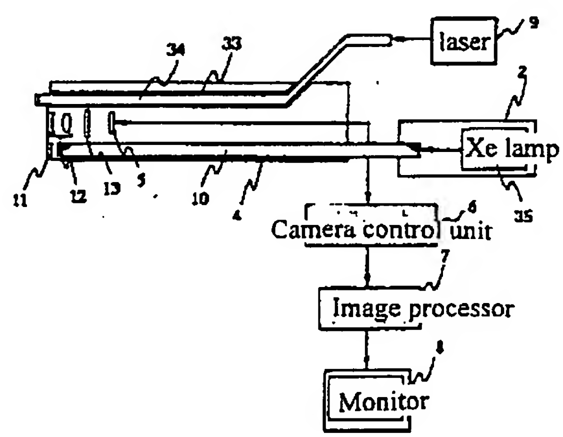
[Fig. 6]



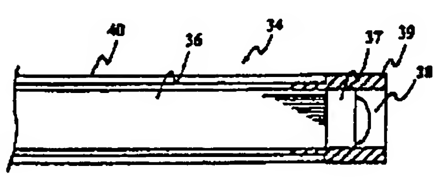
[Fig. 7]



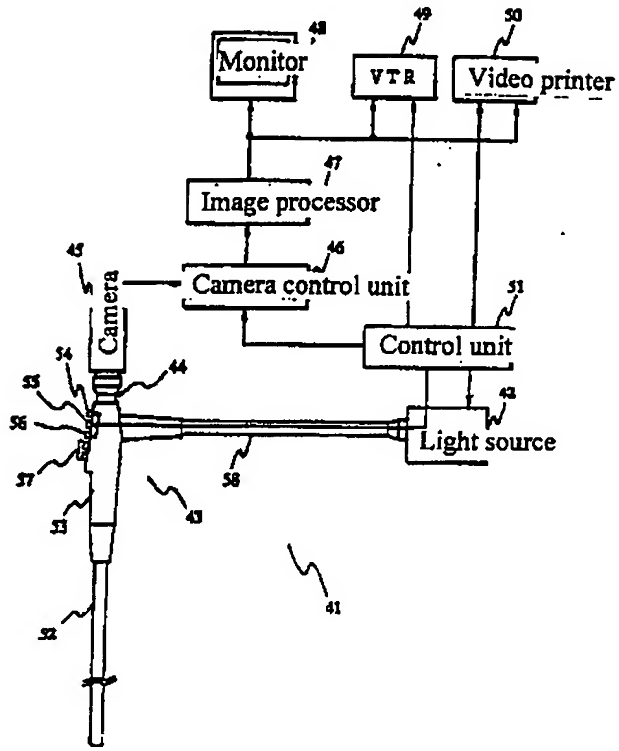
[Fig. 8]



[Fig. 9]



[Fig. 10]



48
Monitor
49
VTR
50
Video printer
47
Image processor
45
Camera
46
Camera control unit
51
Control unit
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55
56
57
44
42
Light source
58
53
43
41
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